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ESTIMATION OF CANONICAL CORRELATION METHOD OF RELATIONS BETWEEN MILK AND WOOL YIELD TRAITS IN AKKARAMAN SHEEP

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Canonical correlation is a multivariate statistical method for determining relationships between data sets. This study was aimed to investigate the relationship between milk and wool yield traits of Akkaraman sheep by using canonical correlation analysis. Data were collected from 36 sheep maintained at the Toprakpinar village of Sarikaya province in Yozgat. The characters associated with milk yield to determine properties of wool from sheep, the two data sets were formed for the analysis. One of the sets (X set) was consisted of wool traits i.e. fleece weight (FW), staple length (SL), fiber length (FL), average number of crimps over a length of 5 cm (ANC) and wool fineness (WF). The other set (Y set) was constituted of marketable milk yield (MY), lactation period (LP), milking period (MP), average daily milk yield (ADMY) and maximum daily milk yield (MDMY). Canonical correlation coefficients between two sets were determinate and evaluated accordingly. The significant canonical correlation between milk yield and sheep fleece was found in Akkaraman. The highest canonical weight was observed in the ondulation fleece properties for time of milking and lactation period. The largest contributor of the formation of the canonical variables was affected by dirty wool weight. The fineness has the lowest effect.
Keywords: Animal husbandry, selection breeding, cattle, fattening period, lactation period, Pearson correlation, regression analysis.

INTRODUCTION

Selection is one of the most used methods in improvement studies to be done in order to increase meat production in animals. However, it is important to know the interactions of the features studied while selecting animals to increase the success of selection. In general, it is known that the simple correlation analysis (Pearson correlation) is the first task to determine the relationships between variables (Keskin and Ozsoy, 2004). In some cases, while the dependent variable is single, independent variables can be many. In such cases, multiple correlations must be used (Keskin *et al.,* 2005). If the number of dependent and independent variables is more than one in the research studies, the mentioned correlation coefficients cannot be used. Instead, to examine the relationship between the data sets formed by the variables, the relationship between the canonical variables is investigated by converting the components of the variables into canonical variables. This process is called canonical correlation (Gurbuz, 1989). Canonical correlation analysis involves many complex processing steps (Tatlıdil, 1996). Although its use is low due to complexity, it is a technique that should be used because it explains the relationship between variable groups quite successfully.

While regression analysis tries to explain a dependent variable with a certain number of independent variables, canonical correlation analysis aims to investigate the relationship between two variable sets in various fields. It helps in finding linear relationships that will provide the highest relationship, especially between different measured characters (such as between morphological and physiological characters) (Gurbuz, 1989; Tatlıdil, 1996). If the calculated correlation is high enough, the importance of each of the morphological characters handled in the physiological character is high or low. Again, canonical correlation analysis is used to investigate relationships with appropriate character groups such as early development, fertility and nutrition (Kocabas *et al.,* 1998; Tatar and Elicin, 2002). Keskin *et al.* (2004) in their studies in brown crossbred cattle, they examined the relationships between milk yield and reproductive characteristics and found the relationship significant with 0.625. Cankaya (2005) found the canonical correlation coefficient as high as 0.931 in the study of German pied and hair goat hybrids. Koskan *et al.* (2011) examined the nutritional properties of the cattle in their study with the sets consisting of 3 features and the second 4 features. Keskin and Dag (2009) examined the relationship between milk yield and wool yield with canonical correlation in their study in Awassi sheep and found the relation coefficient as 0.447 unimportant. Therefore, in this study on the Akkaraman lambs, it was aimed to determine the canonical correlations between the data on wool yield and milk yield characteristics and to determine the early selection criteria or criteria that can be used in terms of growth characteristics in fattening period. In addition, a limited number of studies are reported to determine the canonical correlation methods of relationship

between phenotypic traits in livestock in Turkey and the results obtained would be be important for researchers.

The research is aimed to determine the features involved in animal breeding and the factors affecting them in the simplest and fastest way. Due to application and economic difficulties, it is difficult to estimate milk yield indirectly. Especially considering that many factors affect milk yield, the level of exposure increases. This affects selection negatively in terms of milk yield. The most important auxiliary fleece that guides us in this regard are its features. It is possible to determine which properties are effective on milk yield among the characteristics of wool, what canonical loads are, and whether they can make predictions about production.

MATERIALS AND METHODS

The animal selected in this study was 36 Akkaraman sheep maintained at Toprakpinar village of Sarikaya district of Yozgat province. In the study, wool characteristics (X) especially the dirty wool weight (X1), nozzle length (X2), actual length (X3), undulation (X4) and fineness (X5) of wool yield were determined. Milk yield characteristics (Y) were evaluated as milk yield (Y1), lactation period (Y2), milking time (Y3), daily average milk yield (Y4) and maximum daily milk yield (Y5). As a method, canonical correlation analysis was applied. As it is known, correlation analysis is performed to determine the relationships between the two variables. However, when the number of variables increase, the variables are divided into groups and form two separate groups. Canonical correlation analysis is a method used to reveal relationships between data sets that contain two or more variables. This method gives us valuable information about relationships by calculating the correlation between two variable groups. The canonical correlations between the variable groups are determined independently, so as not to affect each other (Johnson and Wichern, 2002). There are assumptions such as the absence of multiple connections and the sample width being at least five times the number of variables.

In the inter-set correlation analysis, the variable sets have linear components and the correlation between the two variable groups was calculated with the help of canonical variables calculated through the components (Filiz and Kolukisaoglu, 2012). The first pair of canonical variables was the linear combination pair V1 and W1, with variance 1 maximizing the correlation coefficient. The second canonical variable was the linear combinations with unit variance V2 and W2 that maximize the correlation between the variables independent of the first canonical variable. The variance explained in the correlation analysis indicates how much of the variance of the observed variables set of canonical variables for each set (Cannon and Hsieh, 2008). The height of this ratio may explain whether the solution matrix eigen values are sufficient in explaining the correlation between the two observed sets of canonical correlations. The data obtained were analyzed with STATISTICA 6.0 V statistical package program and the results were evaluated by procedure described by Stat Soft (1998).

RESULTS AND DISCUSSION

Descriptive statistics values of wool and milk features are presented in Table 1 which showed serious changes according to the characteristics. It is observed that the coefficient of variation of milk yield was high. This shows that milk yield is much more affected by environmental factors than wool yield. While the average variation amount of wool yield was 9.63%, the average variation of milk yield was determined as 13.56%. While the highest variation was observed in lactation periods with CV 15.96% and milking time with CV 14.58%, the lowest variation was undulation (10.16%). In some studies, it was found significantly lower than the variation rate of 39.79% (Keskin *et al.*, 2004) and is like the variation recorded by Çankaya (2005). The difference is thought to be caused by animal species. It is known that such differences affect the results.

The milk yield characteristics of Akkaraman sheep and the correlation coefficients calculated between fleece yield characteristics are shown in Table 2. It was examined that the relationship between the variables varied greatly. Especially the relation between undulation and dirty fleece weight and nozzle length was statistically significant ($P<0.05$), while the

Table 1. Descriptive statistical values of Akkaraman sheep fleece and milk yield.

Yields	Yield Properties	N	Average	Standard error	Variation coefficient (%)
Fleece Yield	Dirty wool weight (X_1)	36	1412.30	221.63	9.63
	Nozzle length (X_2)	36	7.02	0.41	10.11
	Actual length (X_3)	36	9.88	0.59	11.25
	Ondulation (X_4)	36	10.67	0.53	10.16
	Fineness (X_5)	36	29.74	1.52	10.51
Milk Yield	Milk yield (Y1)	36	47632.00	2847.00	13.56
	Lactation period (Y2)	36	148.13	5.55	15.96
	Milking time (Y3)	36	110.21	7.38	14.58
	Daily average milk yield (Y4)	36	441.23	24.08	11.39
	Daily maximum milk yield (Y5)	36	648.21	30.12	12.47

actual length was found to be significant (P<0.01). In terms of variables, the main relationships were in milk yield variables. Significant and positive relationships were determined between milk yield and lactation period, milking period, daily average milk yield and highest daily milk yield (P>0.01). These features can be used successfully in milk yield studies and milk yield estimations (Basdagianni *et al.*, 2005; Ünal *et al.*, 2007; Yakan, 2012). Milk yield is directly affected by the animal race, season, lactation period, geographical conditions, species and possible diseases (Fleisher *et al.*, 2001; Ocak *et al.*, 2009). It will be appropriate for the researchers to focus on these issues while planning studies on milk yield.

A significant and negative relationship was determined between daily average milk yield and thinness (P<0.01). This shows that as the milk yield increased, the thickness of the wool decreased. However, significant and positive relationships were determined between milking period and lactation period (P<0.05). It is also noteworthy that there was a significant and negative relationship between corrugation and nozzle length and actual length (P<0.01). Berry *et al.* (2003) reported similar results for milking time and lactation time. On the other hand, Tekin *et al.* (1999) studied the fleece characteristics of Turkish Merinos and Etci Races x Turkish Merinos hybrids and reported that the effect of growing and nutritional conditions in the study area was high. Yozgat province Sarikaya district, where the study was conducted, is a very high area and a regular nutrition program is not implemented under the breeder conditions. Therefore, such differences can be seen.

The first canonical correlation coefficient between wool yield and milk yield characteristics was found to be 0.4852 (P<0.05). This calculated value was much higher than the correlation coefficients previously stated between fleece yield and milk yield characteristics. The second, third, fourth and fifth canonical correlation coefficient between fleece yield and milk yield characteristics were 0.4872, 0.4012, 0.3261 and 0.0954 (P>0.05), respectively. Linear combination of variables that provided the highest (first) canonical correlation coefficient was;

$$V_1 = 0.469DWW + 0.581NL - 0.568AL - 0.121OND + 0.501F$$

$$W_1 = 1.327SMY - 0.497LP - 0.727MT - 1.016DAMY + 0.917DMMY$$

It has been determined that the value for the first canonical correlation coefficient (0.4852) was equal to the correlation coefficient between the values of V1 and W1 calculated for each animal.

Canonical weights and loads calculated for fleece and milk yield characteristics in Akkaraman sheep are shown in Table 3. The wool yield of the highest canonical weight was observed in OND (-0.8814), while milk yield was observed in LS (1.1360). In terms of canonical loads, GU (0.2974) was one of the fleece yield characteristics. Canonical weights and loads determined the contribution it makes to both sets of variables, while the canonical weight contributes to the set in quantity, the canonical load contributes to the set in '%'.

Table 3. Canonical weights and loads between wool and milk yield properties of Akkaraman sheep.

Variables	Canonical Weights	Canonical Loads
DWW	0.2105	0.3069
NL	-0.4086	-0.0758
AL	0.2974	0.5128
OND	-0.8814	-0.0699
F	0.1658	-0.0470
MNY	0.1129	0.1736
LP	1.1360	0.6571
MT	-0.6845	0.1692
DAMY	0.8084	0.1713
DMMY	-0.8214	-0.2008

Although the calculated canonical variables are artificial, the calculation of the correlation coefficients between the V1 and W2 indices and the original variables gives them meaning; because the correlation coefficients indicate the contribution amount of any original variable to the canonical variable. Correlation coefficients between fleece yield characteristics and their canonical variables are shown in Table 4.

The correlations between fleece yield characteristics and the canonical variables of fleece differed. Accordingly, the greatest contribution in the formation of canonical variables was made by the dirty wool weight. This was similar for all canonical variables. The contribution of other variables to the

Table 2. Correlations of fleece and milk characteristics in Akkaraman sheep.

Variables	DWW	NL	AL	OND	F	MNY	LP	MT	DAMY	DMMY
DWW	-	0.112	0.252	0.395*	0.101	-0.189	0.106	0.116	-0.135	-0.264
NL		-	0.617**	-0.462*	0.065	0.117	0.178	0.055	0.174	0.086
AL			-	-0.457**	-0.033	0.146	0.198	0.274	0.084	0.102
OND				-	0.154	0.063	0.112	-0.095	0.166	0.084
F					-	-0.299	-0.156	0.078	-0.612**	-0.128
MNY						-	0.691**	0.712**	0.605**	0.768**
LP							-	0.677**	0.324*	0.602**
MT								-	0.417*	0.533**
DAMY									-	0.747**
DMMY										-

Table 4. Correlations between Akkaraman sheep wool yield properties and their canonical variables.

Variables	V_1	V_2	V_3	V_4	V_5
DWW	0.8769	0.9544	0.8954	-0.8525	-0.9451
NL	0.0304	0.3621	0.3021	0.3415	-0.3260
AL	0.0642	0.0401	0.1004	0.0745	0.0412
OND	-0.0478	-0.1842	-0.2236	0.0106	0.0374
F	0.0041	0.0086	-0.0108	-0.0107	0.0211

Table 5. Correlations between Akkaraman sheep milk yield properties and their canonical variables.

Variables	W_1	W_2	W_3	W_4	W_5
MNY	0.8235	0.5842	0.6841	0.9021	0.7175
LP	0.0304	0.5417	0.5210	0.4296	0.5862
MT	0.0472	0.4201	0.5923	0.4085	0.5318
DAMY	0.0401	-0.2014	0.5314	0.8468	0.4178
DMMY	0.6072	0.5362	0.8871	0.7512	0.8082

formation of canonical variables was quite low. The lowest contribution was made by F.

Correlation coefficients between milk yield characteristics and their canonical variables are given in Table 5. It was observed that the greatest contribution to the formation of canonical variables was changed. SV made the biggest contribution in W1, GEFSV in W2 and W3, SVEF in W4 and GEFSV in W5. The contribution of LS, SS and GOSV in the formation of canonical variables was very low. Kayaalp (2008) detected a high amount of canonical relationships between breast diameters (0.9270) and examined the relationship between birth time and some morphological features and live weight in the 6-month period in cattle. Keskin and Dag (2009) found the amount of canonical relationship between milk yield and fleece yield insignificant (0.44473). In addition, Fourie *et al.* (2002) stated that the canonical relation between milk yield and production and somebody measurements was high and important. Similarly, Daşkıran *et al.* (2007) stated that the canonical relationship between live weight and milk production was high and important.

***Conclusion*:** The calculations made in this study showed that 74.12% of the total variance of standardized X set properties (DWW, NL, AL, OND and F) could be explained by the first canonical variable. It has been seen that the standardized Y set properties (MNY, LP, MT, DAMY and DMMY) can be explained by the first canonical variable of the 18.56% of the variance. The canonical correlation coefficient (0.5012) calculated between milk yield and fleece yield was higher than previously calculated correlation coefficients between milk yield characteristics and fleece yield characteristics, and this value was found statistically significant. As a result, it has been shown that it is possible to explain the relationship between milk and fleece yield characteristics by canonical correlation method.

Also, considering the difficulties in interpreting the results obtained, canonical correlation technique can be considered as a rather difficult test. However, it should be remembered that in most biological studies, using canonical correlation analysis instead of simple correlation coefficients will provide additional information to the researchers. For this reason, canonical correlation analysis can be explained successfully in the field of animal husbandry. The breeding conditions of animals generally affect all the features in certain proportions.

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